An Overview of Seismic Discrimination Issues Relevant to CTBT Monitoring

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Abstract

The Conference on Disarmament of the U.N. General Assembly is currently working to draft a Comprehensive Test Ban Treaty (CTBT) which will prohibit all nuclear testing. Because seismology remains as the primary monitoring technique for verifying treaty compliance with respect to underground nuclear tests, it is appropriate at this time to once again review the current state of understanding regarding the seismic identification of such explosions. It is evident that no practical seismic monitoring system will ever insure identification of all conceivable underground nuclear tests and, therefore, it is important to begin any such assessment of capability by recognizing that it is first necessary to establish a monitoring threshold goal, which will ultimately represent some compromise between system cost and various political and military considerations. This goal may vary depending on the perspectives of the groups designing the monitoring systems. For example, the stated design objective of the proposed International Monitoring System (IMS) is to insure the capability to identify all well-coupled underground nuclear tests having yields greater than 1 kt, while the ultimate design threshold of the U.S. NTM system has often been expressed in terms of monitoring evasively tested 1 kt explosions. Such differences in design thresholds have profound implications with respect to the associated required seismic discrimination capabilities. That is, since well-coupled 1 kt nuclear explosions correspond to m_b values of 4.0 or more, most events with magnitudes above the IMS threshold can be effectively identified using data from a capable teleseismic network alone. Moreover, since there are virtually no chemical explosions which generate seismic signals of this magnitude, the IMS identification task is greatly simplified in that the range of source types to be considered is limited. On the other hand, cavity decoupled 1 kt explosions are expected to produce seismic signals corresponding to magnitudes in the range $2.0 < m_b < 2.5$, and such events will not be detected teleseismically. It follows that regional seismic data and associated discrimination techniques will be required to monitor any such U.S. NTM threshold level. Furthermore, current estimates indicate that tamped chemical explosions with yields of less than 10 tons and ripple-fired quarry blasts with yields in the range of 75-100 tons will produce regional seismic signals comparable to those expected from fully decoupled 1 kt nuclear explosions. Since chemical explosions of such sizes are common in many areas of the world, they will have to be routinely discriminated from nuclear explosions in order to monitor at such low threshold levels. More generally, seismic monitoring of any eventual CTBT will likely involve a combination of teleseismic and regional data and will require the routine, confident identification of underground nuclear explosion signatures from a background of signals produced by numerous earthquake, mine blast and rockburst sources. The most reliable seismic discriminants continue to be those based on fundamental source properties such as location (especially depth), geometry and source dynamics. The current status of the development of such discriminants will be summarized and their implications with respect to effective teleseismic and regional monitoring of a CTBT will be assessed.

Key Words: Seismic, Discrimination, CTBT